

Design and Construction of Geotextile Encased Columns Supporting Geogrid Reinforced Landscape Embankments; Bastions Vijfwal Houten in The Netherlands



Bastion West one year after construction

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1. INTRODUCTION

In Houten-Zuid in the Netherlands, landscape embankments (Bastions) were placed almost at the end of the housing projects were planned as a connection between the residential area and the natural landscape around. The landscape hills (Bastion West and East) had to be built with cohesive soils which occurred in the project areas. For these embankments on extremely soft soil, settlement calculations were performed and settlements of 1.6 m to 1.9 m for Bastion West and 0.5 m to 0.8 m for Bastion East were expected to occur. This created a problem because of the extended consolidation time estimated. In addition the considerable settlements endangered an adjacent brick-wall founded on concrete piles to potentially collapse. One other concern was the global stability of the embankments especially due to the excavation of a dewatering canal around the Bastions at the toe of the embankment. Several options for the construction of the Bastions were analysed, however the use of geosynthetic encased columns (GECs) was found to be the best solution with regard to the reduction of the settlements as well as to the improvement of the global stability of the embankments.

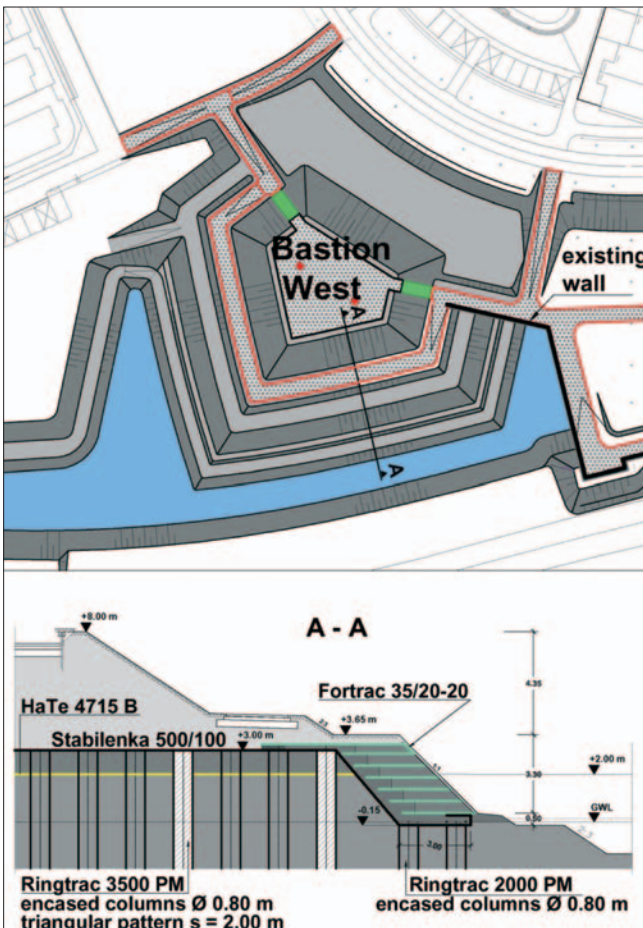


Figure 1. Bastion West

Furthermore, the total construction period was shortened because eighty percent of the consolidation took place during the construction work.

2. DESIGN

The main idea of the GEC-System is to transfer the embankment load through the soft soil to a firm stratum. Thereby, the embankment load is borne mainly by the encased columns. However, the surrounding soft soil provides lateral support to the columns and bears a minor part of the vertical surcharge. The vertical deformations as well as the load distribution between the columns and the soft

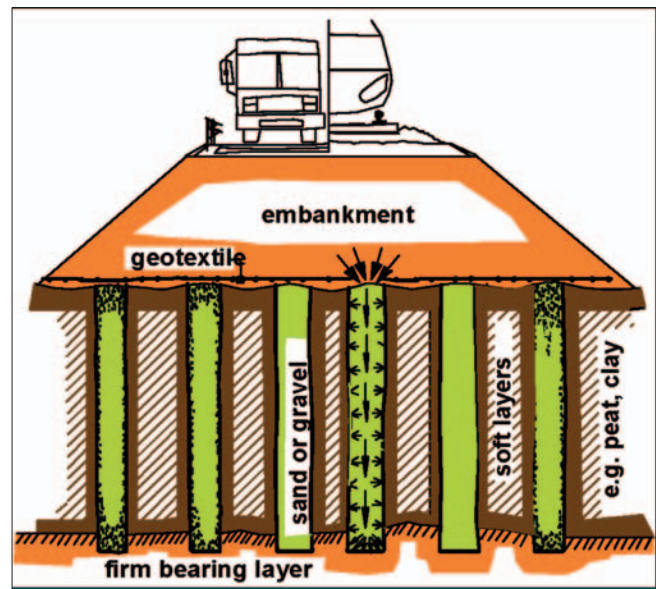


Figure 2. General GEC principle

soil are defined by the tensile strength and the stiffness of the encasement. Since the soft soil is involved in the transfer of vertical loads, the drainage function of the GEC's, acting as vertical drains, is also important to reduce the consolidation time of the system. A design method which allows an estimation of settlements, an analysis of the required radial tensile strength of the encasement and an analysis of the distribution of vertical stress between the columns and the soft soil was presented by Raithel (1999).

The solutions shown in Table 1 were determined as the most suitable ones. Comparing the design of the Bastions it must be taken into account that the allowed settlement at Bastion West was considerable larger.



Figure 4. GEC-Installation

The Royal BAM Group operated at both Bastions with the same equipment changing only the length of the steel casing. Using this equipment up to 40 GECs per day were installed. The result of a load test at Bastion-East compared to the estimated settlement behaviour is shown in Fig 5.

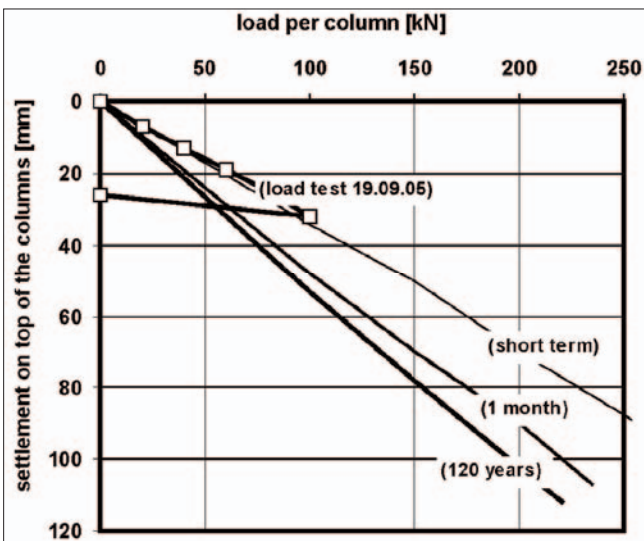


Figure 5. Estimated settlements and load tests at "Bastion East"

After the foundation work was finished the contractor van Wyk progressed with the construction. Since all GEC's were installed from the same level the length of some columns had to be adjusted. These columns were uncovered and shortened according to the final design. Furthermore, the canals around the Bastions were excavated. After the ground surface was shaped the horizontal



Figure 6. Installed GEC at Bastion East

geotextile was installed. Finally the Bastion embankments were built on the prepared platform. After a period of consolidation of 2 months the works were planned to progress with the construction of the roads and facilities at the Bastions.

4. CONCLUSION

The use of this foundation system seems to be suitable particularly if the subsoil in place is too weak ($c_u < 15 \text{ kN/m}^2$) to be treated with regular stone or gravel columns and the structure does not require completely stiff and settlement-free pile elements. The GECs are an appropriate supplement to conventional foundation systems.

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